Industrial Effluent Discharge Altered Proximate Composition of the Marine Fish

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A B S T R A C T

The present study was carried out to estimate the effect of the industrial effluent discharge on proximate composition of commercial landing six fish species in Gulf of Mannar. It was found that, there was variation in moisture, fat and ash content (*Sardinella longiceps*, *Selaroides leptolepis*, *Epinephelus quoyanus* and *Lethrinus lentjan*) between the industrial and non-industrial area and also the fat and ash had a statistical significance at 5 and 10% level but no significant change in *Penaeus semisulcatus* and *Portunus sanguinolentus*. However, this study concludes that there was a negative impact of industrial pollution discharge on the proximate composition of commercial landing of fish species. Therefore, future studies should emphasis micronutrient assessment of the commercial landing species between the industrial and non-industrial area for better understanding changes.

Introduction

Coastal zones are highly productive; this potential has declined due to anthropogenic activities such as industrial, domestic, municipal discharges (Kumaraguru *et al.,* 2006). These affected the quality of the environment, biodiversity, and ecosystem, ultimately altering the nutritional composition of marine living organisms (Blevins and Pancorbo, 1986; Govind and Madhuri, 2014). The increased concentration of heavy metals also observed due to industrial development in near shore waters at thermal power plants. However, fish are exerted typically to monitor

variation in the marine environmental condition due of anthropogenic activities. They are having an important role in transferring the media because they cause serious of environmental hazards. In Kayalpattinam, fish mortality has reported due to an inflow of industrial effluents. The accumulation of chlorinated pesticide observed in ray, tributyl tin has also been observed in water and sediment at Thoothukudi harbour (Kumaraguru *et al.,* 2006). Many studies have conducted to measure industrial effluent discharge by using water quality variation, but few studies were performed in the Gulf of Mannar region to

measure the effect of the industrial effluent discharge based on fish samples. Also, this considered as Hotspot biodiversity of fish, thereby a regular monitor is essential because of the rapid development of a coastal area and increasing numbers of industrial tourisms. This present investigation done with the hypothesis that there is no statistically significant difference of proximate composition of fish in the landing of industrial and non-industrial area. Hence, commercially valuable six species were selected namely Indian oil sardine *Sardinella longiceps* Valenciennes, 1847, Yellow stripe scad *Selaroides leptolepis* Cuvier, 1833, Longfin grouper *Epinephelus quoyanus* Valenciennes, 1830, Pink ear emperor *Lethrinus lentjan* Lacepède, 1802, green tiger prawn *Penaeus semisulcatus* de Haan, 1844, and Blood-spotted swimming crab *Portunus sanguinolentus* Herbst, 1783.

Materials and Methods

The present study was carried out in Gulf of Mannar coast ($8^0 55''$ – $9^0 15'$N; $78^0 0'$ – $79^0 16'$E) of India and which lie in the coastal area from Rameswaram to Kanyakumari. The fish and crustacean samples were obtained from industrial area landing centre Thoothukudi is located $8^0 47'$N and $78^0 09'$E, and the non-industrial landing centre Keelakarai is located $9^0 13'$N and $78^0 47'$E (Figure 1). The selected species were identified using FAO species identification sheets (Fischer and Bianchi, 1984). Six samples collected from each landing centre, these samples were stored on ice, transported to the laboratory in an insulated ice box, preserved at -18°C until itemization.

Proximate compositions of fish were estimated by the conventional method Association of Official Analytical Chemicals (AOAC) on the basis of wet weight (AOAC, 1987). The level of moisture was determined by drying in a hot air oven at a temperature of 100+2ºC for 16 hrs and weighted for the weight loss. Dried samples were used to estimate the crude protein, crude fat, ash, and carbohydrate. Total nitrogen was assessed using micro-Kjeldhal method; multiplying total nitrogen content with factor 6.25 calculated the crude protein. The crude fat determined by solvent extraction method. The ash content was analyzed using a muffle furnace at 550 – 600ºC.

Data is presented as mean and SE. The data normality and homogeneity were checked by Kolmogorov-Smirnov Test and Levene's respectively. The mean values of the data were compared between the two study localities for each proximate parameter for individual fish analyzed by student 't' test using Statistical Package of the Social Science (SPSS) version 20. The p value, less than 5 and 10% considered as a statistically significant. The correlation coefficient was performed to establish the relationship amid proximate parameters.

Results and Discussion

The proximate composition of *Sardinella longiceps* is presented in Table 1. The moisture and protein of *Sardinella longiceps* from industrial and non-industrial area were weakly and negatively correlated (r = -0.25, -0.17 respectively) and fat, ash and carbohydrate positively correlated (r = 0.78, 0.42 and 0.06 respectively). There was a significant average difference in protein and fat between the industrial and non-industrial area (t = 2.349 and t = -2.269, p <0.10). On average, fat was 0.16 higher in non-industrial area than the industrial area [96% CI (-0.34, 0.02)]. Table 2 revealed that, the mean ash content of *Selaroides leptolepis* differ between the industrial area (M = 1.44, SE = 0.02) and non-industrial area (M = 1.50, SE = 0.02) at the 0.10 level significance (t = - 2.35,

95%CI -0.12 to 0.01). A moderate positive correlation (r = 0.39) found between the industrial and non-industrial area. Besides, an average non-industrial area tends to have higher moisture, fat, and ash than the industrial area.

The fat and ash of *Epinephelus quoyanus* were found to be higher in non-industrial area (0.45, 1.52 respectively) than that of the industrial area (0.40, 1.44 respectively). There was a statistical significant at 0.05 level (t = -2.674 and t = -3.784 respectively). And the moisture, protein and carbohydrate don't found any statistical significance between the industrial and non-industrial area. Also, a

positive correlation was recorded for the fat and carbohydrate and negative correlation for the moisture, protein and ash between the industrial and non-industrial area. Likewise, in *Lethrinus lentjan*, the fat and ash were found to be statistically significant at 0.10 level between the study area (t = -2.050 and t = -2.111, p <0.10). An average, this was noted that the non-industrial area had higher fat and ash content than that of the industrial area (95% CI -0.13 to 0.01 and -0.18 to 0.02 respectively). There was no statistical significance in proximate composition for *Penaeus semisulcatus* and *Portunus sanguinolentus* between the industrial and non-industrial area (Table 3–6).

Table.1 Proximate composition of the *Sardinella longiceps*

Outcome	Thoothukudi		Keelakarai		95% CI for Mean Difference			
	M	SE	M	SE	Lower	Upper	t	Correlation
Moisture	74.27	0.18	74.73	0.16	-1.14	0.22	-1.749	-0.25
Protein	16.93	0.18	16.35*	0.13	-0.05	1.20	2.349	-0.17
Fat	6.51	0.09	6.67*	0.11	-0.34	0.02	-2.269	0.78
Ash	1.45	0.07	1.34	0.03	-0.04	0.26	1.852	0.42
Carbohydrate	0.37	0.02	0.37	0.01	-0.05	0.07	0.374	0.06

Mean values and standard error (mean ± SEM) are presented for each parameter (n=6). The * in a same row indicate significant differences among treatments for a given parameter (P<0.05, student t test)

Table.2 Proximate composition of the *Selaroides leptolepis*

Outcome	Thoothukudi		Keelakarai		95% CI for Mean Difference			
	M	SE	M	SE	Lower	Upper	t	Correlation
Moisture	77.68	0.18	77.73	0.14	-0.64	0.53	-0.242	0.00
Protein	19.77	0.21	19.45	0.13	-0.21	0.85	1.551	0.34
Fat	0.39	0.01	0.40	0.03	-0.06	0.06	-0.092	0.39
Ash	1.44	0.02	1.50*	0.02	-0.12	0.01	-2.35	0.39
Carbohydrate	0.39	0.03	0.36	0.02	-0.04	0.10	0.972	0.26

Mean values and standard error (mean ± SEM) are presented for each parameter (n=6). The * in a same row indicate significant differences among treatments for a given parameter (P<0.05, student t test)

Table.3 Proximate composition of the *Epinephelus quoyanus*

Outcome	Thoothukudi		Keelakarai		95% CI for Mean Difference			
	M	SE	M	SE	Lower	Upper	t	Correlation
Moisture	78.24	0.12	78.36	0.16	-0.81	0.58	-0.437	-0.78
Protein	18.91	0.14	18.85	0.18	-0.65	0.77	0.222	-0.44
Fat	0.40	0.02	0.45**	0.01	-0.10	0.00	-2.674	0.15
Ash	1.44	0.02	1.52**	0.01	-0.15	-0.03	-3.784	-0.01
Carbohydrate	0.36	0.02	0.36	0.01	-0.04	0.04	0.000	0.40

Mean values and standard error (mean ± SEM) are presented for each parameter (n=6). The ** in a same row indicate significant differences among treatments for a given parameter (P<0.10, student t test)

Table.4 Proximate composition of the *Lethrinus lentjan*

Outcome	Thoothukudi		Keelakarai		95% CI for Mean Difference			
	M	SE	M	SE	Lower	Upper	t	Correlation
Moisture	78.23	0.14	78.43	0.12	-0.75	0.35	-0.930	-0.40
Protein	18.80	0.19	18.73	0.15	-0.60	0.74	0.255	-0.18
Fat	0.43	0.03	0.49*	0.01	-0.13	0.01	-2.050	0.17
Ash	1.43	0.03	1.52*	0.02	-0.18	0.02	-2.111	-0.14
Carbohydrate	0.39	0.03	0.36	0.01	-0.03	0.10	1.256	0.27

Mean values and standard error (mean ± SEM) are presented for each parameter (n=6). The * in a same row indicate significant differences among treatments for a given parameter (P<0.05, student t test)

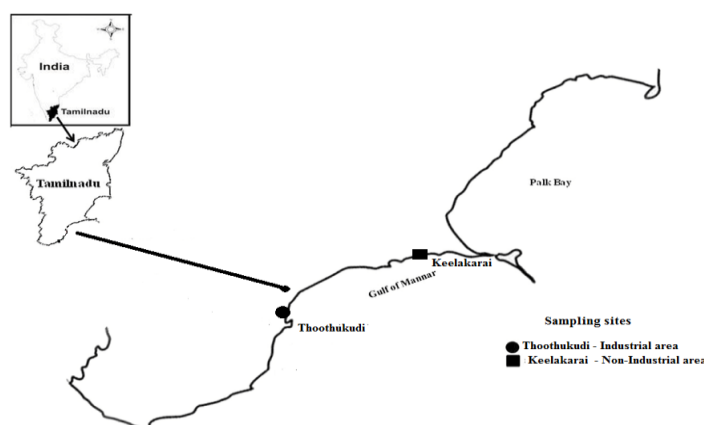**Table.5** Proximate composition of the *Penaeus semisulcatus*

Outcome	Thoothukudi		Keelakarai		95% CI for Mean Difference			
	M	SE	M	SE	Lower	Upper	t	Correlation
Moisture	77.76	0.23	78.09	0.14	-0.85	0.19	-1.632	0.49
Protein	19.21	0.23	18.98	0.17	-0.24	0.70	1.263	0.61
Fat	0.54	0.04	0.61	0.02	-0.18	0.03	-1.812	0.12
Ash	1.49	0.02	1.49	0.01	-0.08	0.09	0.051	-0.53
Carbohydrate	0.40	0.02	0.37	0.02	-0.03	0.10	1.415	0.15

Mean values and standard error (mean ± SEM) are presented for each parameter (n=6)

Table.6 Proximate composition of the *Portunus sanguinolentus*

Outcome	Thoothukudi		Keelakarai		95% CI for Mean Difference			
	M	SE	M	SE	Lower	Upper	t	Correlation
Moisture	81.74	0.15	81.66	0.13	-0.50	0.65	0.321	-0.21
Protein	16.09	0.12	16.17	0.15	-0.60	0.44	-0.388	-0.11
Fat	0.31	0.02	0.33	0.01	-0.09	0.05	-0.661	-0.36
Ash	1.33	0.01	1.34	0.01	-0.06	0.03	-0.889	0.09
Carbohydrate	0.09	0.02	0.07	0.03	-0.10	0.13	0.352	-0.56

Mean values and standard error (mean ± SEM) are presented for each parameter (n=6)

Fig.1 Map showing the study area, Gulf of Mannar, India

Oil Sardine, *Sardinella longiceps* proximate composition was studied in Parangipettai coastal waters of Tamil Nadu (Marichamy *et al.,* 2012); and found that the crude protein (26.37%), lipids (20.1%), carbohydrate (6.41%), ash (0.94%) and moisture content (69.13%). The proximate composition of *Sardinella fimbriata* and he found 41.3% moisture, 20.26% protein and 10.5% lipid, and 0.05 % ash (Immaculate *et al.,* 2012). These values are found to be higher than the present study area. The proximate composition of *Sardinella longiceps*; 72.8% of moisture, 20.7% of protein, 4.8% of fat and 0.5% of carbohydrate (Sen, 2005; Vijayakumar *et al.,* 2014) recorded the proximate composition (14.57% of protein, 6.3% of lipids, 3.1% of ash, 1.7% of carbohydrate, and 73.33% of moisture) of *Sardinella longiceps* in Thengaithttu estuary,

and these findings are comparatively was lower than the present observation. However, the moisture and fat were higher in the non-industrial area than that of the industrial area.

The estimated proximate composition of marine fin fish and shellfish in Peninsular Malaysia, the *Selaroides leptolepis* species had the 79.84% of moisture, 19.98% of protein, 2.12% of fat, 0.93% of ash, and the carbohydrate was nil (Nurnadia *et al.,* 2011; Palanikumar *et al.,* (2014)) reported that the moisture 75.01%, protein 19.18%, fat 2.89%, ash 1.41% and carbohydrate 0.228% content, these was compatible to the results present finding in *Selaroides leptolepis* except fat content which was 2.89. Empirical results of this study were confirmed by the reports of Nurnadia *et al.,* (2011) and Palanikumar *et al*. (2014). Despite, the highest content of

protein, fat and ash were recorded in non-industrial (Keelakarai) when it compared to the industrial area (Thoothukudi).

The *Epinephelus tauvina* proximate composition (77.70% moisture, 19.2% crude protein, and 0.58% crude fat, and 1.29% ash) was studied (El-Faer *et al.,* 1992). The proximate composition of *Epinephuluss exfasciatus* was studied and reported that 78.69%, 18.87%, 3.46%, 0.96% and 0% of moisture, protein, fat, ash, and carbohydrate, respectively (Nurnadia *et al.,* 2011). Palanikumar *et al.,* (2014) reported that of 78.99% moisture, 16.84% protein, 0.85% fat, 3.79% ash and 0.05% carbohydrate for the *Epinephelus areolatus* in Thoothukudi. Observations of the present investigation are paring with easier studies on *Epinephelus sp* but, the variation has recorded between the study in the moisture, fat and ash content. The protein was higher in industrial area than the non-industrial area.

The *Lethrinus genivittatus* had 75.93% moisture, 22.53% protein, 1.22 % fat, 1.20% ash content and, 79.06%, 18.66%, 1.22% and 1.08% respectively for the *Lethrinus mahsena* 79.18%, 18.87%, 0.91%, and 0.91% respectively for the *Lethrinus harak* species as reported in red sea (Hanna, 2001). The proximate composition in the *Lethrinus rivulatus* muscles had 77.37% moisture, 20.00% protein, 1.22% fat and 1.58% ash (Boran and Karacam, 2011). The protein content of *Lethrinus lentjan* species varied from 18.75 to 23.84, carbohydrate ranged from 1.12 to 1.75% and lipid ranged from 7.28 to 9.88% at ChinnaMuttomharbour, Kanyakumari (Mathana*et.al*., 2012). The proximate composition of *Lenthrinus lentjan*, and reported moisture 79.59%, protein 18.56%, fat 0.45 and ash 1.18% in Arabina Gulf coast of Saudi Arabia (Younis *et al.,* 2011). The fat and ash content was higher in Keelakarai (non-industrial area) as compared

to Thoothukudi (industrial area) but protein higher in industrial area.

The proximate composition of *Penaeus monodon* and reported moisture 74.18%, protein 20.34%, lipids 1.40% and carbohydrate 3.66% (Marichamy *et al*., 2011). The said proximate composition of prawn as moisture 79.47%, protein 19.12%, fat 1.06%, ash 1.35% and carbohydrate 0% (Nrnadia and Azrin, 2011). *Penaeus semisculatus* on the other hand had a moisture content of 76.94%, protein (20.3%), fat (0.51%) and ash (1.30%). In the present study *Penaeus semisculatus* was found to be slightly higher than those value obtained by previous studies (Marichamy *et al.,* 2011; Nrnadia and Azrin, 2011) with to exception of protein content which was about 19%. The proximate composition of red crab (*Portunus pelagicus*) was an average 86% moisture, 10.3% protein, and 1.96% ash and 0.67% fat (Badavi, 1971). The moisture content of the male *Portunus pelagicus* was of 79.87%, protein 19.27%, ash 1.84%, and fat 0.15% recorded and while the in female crab 83.25% of moisture, 16.19% of protein, 1.35% of ash, 0.16% of fat (Ameer Hamsa, 1978). The soft shelled *Portunus sanguinolentus* was that of, protein 17.17%, lipid 1.50 % and carbohydrate 0.68% (Sudhakar *et al.,* 2009). However, value of chemical composition of the present study is agreement with value obtained the other studies (Ameer Hamsa, 1978). The protein content was higher than that of (Badavi, 1971), lower than results of (Sudhakar *et al.,* 2009). No variation of proximate composition (*Penaeus semisculatus* and *Portunus sanguinolentus*) was noticed between the industrial and non-industrial area.

The proximate composition varied from one species to other species which could be affected by diverse factors including age, sex, spawning cycle, environmental conditions and seasons (Exter *et al.,* 1975; Huss, 1988; Huss,

1995, Bolawa *et al*., 2011), migration, starvation, over feeding, even when the samples are taken from the same catch, the composition of fish varies considerably (Boran and Keracam 2011; Shaji and Hindumathy, 2013). The factors including the size, ecological, physical, and nutritional status of the fish may influence the proximate composition in the fish (Marichamy *et al.,* 2011). Effect of diesel oil pollution on proximate compositions and mineral nutrient of *Occimum gratissimum* leaves has studied (Ekpo *et al.,* 2014). The concentration of diesel oil pollution negatively affected the proximate and nutrient composition of fish. The proximate composition of selected fin and shell fish analysed between the industrial and non-industrial area, shows a narrow range of variations especially in moisture, fat, and ash content.

In conclusion the present study concludes that there was a significant alteration in the proximate composition especially in the fat and ash content of the fish in the industrial area when it compared to the non-industrial area. Future studies should give importance to assess the micronutrient of the commercial landing fish species on this coast for the better understanding effect of industrial area.

Acknowledgement

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